

CLAIMS

What is claimed is:

1. A method of making a contact structure as part of an integrated circuit on a wafer comprising:
 - providing a silicon region as a portion of said semiconductor wafer for making electrical contact thereto;
 - depositing a dielectric layer over at least a portion of the silicon region;
 - forming a contact opening through the dielectric layer exposing a portion of the silicon region, the contact opening having a side wall;
 - depositing a titanium metal layer within the contact opening covering at least a portion of the silicon region exposed by the contact opening;
 - depositing a predominantly amorphous titanium carbonitride film having predominantly no definite crystalline structure and having predominantly no crystalline titanium therein, the predominantly amorphous titanium carbonitride film lining at least a portion of the side wall of the contact opening overlaying at least a portion of the titanium metal layer covering the portion of the silicon region exposed by the contact opening; and
 - filling at least a portion of the contact opening using a material.
2. The method of claim 1, wherein depositing the predominantly amorphous titanium carbonitride film comprises a chemical vapor deposition process.
3. The method of claim 2, wherein the chemical vapor deposition process includes:
 - evacuating a deposition chamber to a pressure of less than about 100 torr;
 - heating the semiconductor wafer to a temperature within a range of about 200°C to about 600°C;
 - maintaining the temperature of the semiconductor wafer within the range of about 200°C to about 600°C;

admitting an organometallic precursor compound into the deposition chamber, the organometallic precursor compound including a tetrakis-dialkylamido-titanium compound;

decomposing the organometallic precursor compound at least near the surface of the semiconductor wafer; and

depositing the predominantly amorphous titanium carbonitride film having predominantly no definite crystalline structure and having predominantly no crystalline titanium therein on at least a portion of the surface of the semiconductor wafer and within at least a portion of the contact opening.

4. The method of claim 3, wherein the organometallic precursor compound comprises tetrakis-dimethylamido-titanium.

5. The method of claim 1, wherein the material comprises a metal selected from the group consisting of tungsten, aluminum, copper and nickel.

6. The method of claim 1, wherein the material comprises doped polycrystalline silicon.

7. The method of claim 1, further comprising:
heating the semiconductor wafer; and
reacting at least a portion of the titanium metal layer covering the portion of the silicon region exposed by the contact opening with the silicon region to form a titanium silicide layer.

8. The method of claim 7, wherein the reacting the at least a portion of the titanium metal layer with the silicon region occurs prior to depositing the predominantly amorphous titanium carbonitride film having predominantly no definite crystalline structure and having predominantly no crystalline titanium nitride therein.

9. The method of claim 7, wherein the reacting the at least a portion of the titanium metal layer with the silicon region occurs subsequent to depositing the predominantly amorphous titanium carbonitride film having predominantly no definite crystalline structure and having predominantly no crystalline titanium nitride therein.

10. The method of claim 1, further comprising:
subjecting the predominantly amorphous titanium carbonitride film having predominantly no definite crystalline structure and having predominantly no crystalline titanium therein to rapid thermal processing in the presence of one or more gases selected from the group consisting of nitrogen, hydrogen and the noble gases.

11. A method of making a contact structure as part of an integrated circuit on a wafer having at least one silicon region as a portion thereof comprising:
depositing a dielectric layer over at least a portion of the silicon region;
forming a contact opening through the dielectric layer exposing a portion of the silicon region,
the contact opening having a side wall;
depositing a titanium metal layer within the contact opening covering at least a portion of the silicon region exposed by the contact opening;
depositing a predominantly amorphous titanium carbonitride film having predominantly no definite crystalline structure and having predominantly no crystalline titanium therein, the predominantly amorphous titanium carbonitride film lining at least a portion of the side wall of the contact opening overlaying at least a portion of the titanium metal layer covering the portion of the silicon region exposed by the contact opening; and
filling at least a portion of the contact opening using a material forming a contact.

12. The method of claim 10, wherein depositing the predominantly amorphous titanium carbonitride film comprises a chemical vapor deposition process.

13. The method of claim 12, wherein the chemical vapor deposition process includes: evacuating a deposition chamber to a pressure of less than about 100 torr; heating the semiconductor wafer to a temperature within a range of about 200°C to about 600°C; maintaining the temperature of the semiconductor wafer within the range of about 200°C to about 600°C; admitting an organometallic precursor compound into the deposition chamber, the organometallic precursor compound including a tetrakis-dialkylamido-titanium compound; decomposing the organometallic precursor compound at least near the surface of the semiconductor wafer; and depositing the predominantly amorphous titanium carbonitride film having predominantly no definite crystalline structure and having predominantly no crystalline titanium therein on at least a portion of the surface of the semiconductor wafer and within at least a portion of the contact opening.

14. The method of claim 13, wherein the organometallic precursor compound comprises tetrakis-dimethylamido-titanium.

15. The method of claim 10, wherein the material comprises a metal selected from the group consisting of tungsten, aluminum, copper and nickel.

16. The method of claim 10, wherein the material comprises doped polycrystalline silicon.

17. The method of claim 10, further comprising: heating the semiconductor wafer; and reacting at least a portion of the titanium metal layer covering the portion of the silicon region exposed by the contact opening with the silicon region to form a titanium silicide layer.

18. The method of claim 17, wherein the reacting the at least a portion of the titanium metal layer with the silicon region occurs prior to depositing the predominantly amorphous titanium carbonitride film having predominantly no definite crystalline structure and having predominantly no crystalline titanium nitride therein.

19. The method of claim 17, wherein the reacting the at least a portion of the titanium metal layer with the silicon region occurs subsequent to depositing the predominantly amorphous titanium carbonitride film having predominantly no definite crystalline structure and having predominantly no crystalline titanium nitride therein.

20. The method of claim 10, further comprising:
subjecting the predominantly amorphous titanium carbonitride film having predominantly no definite crystalline structure and having predominantly no crystalline titanium therein to rapid thermal processing in the presence of one or more gases selected from the group consisting of nitrogen, hydrogen and the noble gases.